AMENDED SPECIFICATION

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PATENT SPECIFICATION

742,683

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COMPLETE SPECIFICATION

Heater for Fuel Oil or other Viscous Liquids carried in Ships

I, FERRUCCIO CASINGHINI, of Italian nationality, of Via Larga, 9—Milan, Italy, trading as F. CASINGHINI ECONOMIZZATORI GREEN, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a system for heating fuel oil or other viscous liquids transported by oil tankers or contained in tanks or double bottoms on board ships so as to enable them to be pumped with rapidity.

Considering however the particular use of oil tankers, the invention is concerned principally with that type of ship.

For oil tankers, the method most commonly employed is to furnish them with a series of smooth steel pipes arranged horizontally in coils on the bottom of the tanks in such a manner as to transmit from the heating fluid passed through the pipes the necessary amount of heat to the viscous liquid by means of the convective motions induced therein. The use of steel pipes which, at first sight, might appear to be the simplest and most economical method, on the contrary gives rise to considerable trouble while the maintenance cost is such as to annul the benefit of the comparatively low first cost. It must, in fact, be borne in mind that the tanks or double bottoms usually employed for containing the aforesaid liquids are, for reasons of stability, often filled with sea water to provide the necessary ballast on journeys when the ship is unloaded or only partly loaded. The sea water, in general, stagnates on the bottom of the tanks or double bottoms if they are filled with fuel oil because it is not possible to pump out all the bilge water and because water separates by decantation. If sea water is contained in the liquid taken on board, it invariably comes into contact with the heating coils which necessarily are accommodated on the bottom of the tanks or double bottoms where they find support among the longitudinals or other structural members or among the floors of the hull of the ship. The rolling and pitching movements of the ship favour this phenomenon even if the quantity of sea water present is quite limited.

It is known that sea water exerts a strongly corrosive action on ordinary steel, which, as in the case in point, cannot be protected from direct contact with the sea water.

Experience shows that serious corrosion takes place with steel tubes, perforating them in an average period of from two to four years.

This renders it necessary to replace the pipes with the same frequency and such replacement is very costly because it may be found necessary to lay up the ship in dock to carry out replacement. It is further pointed out that if, due to such corrosion, replacement of the pipes is not effected in due time, there is a danger which has sometimes caused heavy damage to ships and individuals. As a matter of fact, even if at only one point the corrosion has penetrated so far as to perforate the wall thickness of the steel pipe, there is a possibility of mutual pollution of the fluids, which is dangerous mainly because, when heating is over, e.g. heating by steam, the pressure drop produced by the steam condensate can suck into the pipes some of the surrounding viscous liquid which, in this particular instance, is usually a petroleum product, generally of an inflammable nature; the emptying of the tanks or double bottoms and the subsequent operations may lead one to believe, as indeed has happened, in a complete absence of gas in said tanks or double bottoms, while said gas may be produced after a certain time by petroleum products sucked into the pipes, with all the consequences which a case of this kind can give

rise to. The consideration of the economic damage and of the expenses of replacing steel pipe coils has led one to seek a system which:

1) Calls for replacement only after many years, and

2) prevents for very many years any mutual pollution of the heating and heated fluids.

The idea of substituting steel pipe coils by cast-iron pipes was discarded because the latter material does not possess the mechanical characteristics necessary to withstand in all safety the stresses set up by the weight of the pipes, the water-hammer that may arise inside the pipes, and the other complex stresses to which the hull of a ship is subjected when at sea. It would be theoretically possible to provide a system composed entirely of cast-iron which would satisfactorily meet the requirements indicated above only by employing a material of particularly high resistance to mechanical stresses (apart from its corrosion resistance qualities) and, moreover, by choosing for the pipe such a wall thickness as to remarkably increase both the cost of installation and the load displacement of the ship, especially if it is an oil tanker, which would render such an application unpractical.

On the other hand, the system employed during recent years, i.e. steel pipe coils, although presenting very serious drawbacks as far as resistance to corrosion is concerned, afforded a guarantee of safety from the purely mechanical point of view as steel has in this field the best properties of resistance and elasticity.

It is a purpose of the present invention to provide a system comprising both the advantages of steel and those of cast iron, whilst, at the same time, doing away with the drawbacks due to the use of one rather than the other material and whilst retaining an arrangement of the pipes which is more or less the conventional one namely constituted by a certain number of pipes having horizontal axes connected in series or in parallel according to the requirements of circulation of the heating fluid.

According to the present invention there is provided a heat exchanger for heating fuel oil or other viscous liquids carried in tanks or double bottoms of a ship, comprising a container constituted by the inner surfaces of the tanks or double bottoms in which the viscous liquid to be heated is stored, and a plurality of conduits or pipes disposed on said container for transmitting heating fluid internally therethrough, each of said conduits or pipes including an inner tubular steel conduit and an outer externally finned cast iron jacket mounted on the tubular conduit in such manner as to prevent the fuel oil or other viscous liquid from coming into contact with the steel conduit, means being provided for introducing heating fluid into each conduit or pipe and for discharging said heating fluid after it has passed through said conduits or pipes. The cast iron jackets prevent the fluid contained in the tanks or double bottoms from coming into contact with the steel pipes, thus protecting the system against corrosion.

In this way one attains the desired safety from the mechanical point of view since the relative mechanical stresses are absorbed by the steel, as well as the desired safety in operation and duration from the point of view of corrosion since the viscous fluid, the sea water or other liquids that may be contained in the tanks come into contact with the cast iron surfaces and not with the steel. Concerning the heat transfer problem it should be borne in mind that the heat transmitted by the heating fluid, in general condensing steam, to the steel pipes, is transmitted to these with a high coefficient of thermal conductivity.

This heat has then to be transferred to the external cast-iron elements and, therefore, the system of joining cast-iron to steel becomes very important.

A high-coefficient of heat transfer is ensured by hot-forcing of the cast-iron elements over the steel pipes after previous machining of the two contact surfaces. The heat is, eventually, to be transmitted from the cast iron element to the surrounding viscous liquid, generally fuel-oil.

Since the coefficients of heat transfer from the heating fluid to the steel pipe, through the steel pipe, from the steel pipe to the cast-iron element and, through the cast-iron element, are very high, while that from the external surface of cast-iron to the liquid contained in the tanks or double bottoms is many times lower than those aforementioned and than the overall heat transfer coefficient between the heating fluid and the external cast-iron surface, said surface, according to the invention, is suitably extended. The installation according to the invention may have the shape and the structure diagrammatically shown, by way of example only, in the accompanying drawings, wherein:

Figures 1, 2 and 3 are views of an installation in plan, in longitudinal elevation and in end elevation, respectively.

Figure 4 is an axial section of a portion of the heating element.

Referring to Figures 1 to 3 of the drawings, A indicates the valve connexion whereby the installation is connected to the source of heating fluid, e.g. steam. B is the steam inlet manifold. A plurality of finned heating elements C are arranged in a substantially horizontal plane near the bottom of the vessel. The fins on elements C extend radially from and transversely to the axes of the elements. The heating elements C are formed in sections which are connected together by means of coupling flanges D. At each opposite end, a second plurality of heating elements V are arranged in a substantially vertical plane and are fitted with radially extending longitudinal

fins and connected to the horizontally arranged heating elements by means of curved connecting pipes E. The heating fluid is admitted to the heating elements V through the valve A and inlet manifold B and is dicharged therefrom via an outlet manifold F and a valve member G which is adapted to be connected to the discharge circuit. The inlet and outlet valves and manifold are mounted near the top of the container. As shown in dotted lines in Figure 1, H indicates a divisional watertight bulkhead and I transverse watertight bulkheads, while the line L is the centre line of the ship.

In Figure 4, M indicates the steel pipe and N the cast-iron sleeve, provided with a series of circular fins generally having the shape and dimensions represented in the accompanying drawings: these radial fins may have, however, different form and size, the feature of radially extending fins being generally contemplated in the present invention and the radial fins need not necessarily have a uniform radial extension.

The shape and size of the fins, as shown in the drawing, have been specially designed in order to achieve a satisfactory heat transfer through the various elements in series, taking into account the characteristics of heat flow through the successive surfaces and the viscosity of the liquid to be heated as well.

It should be remarked that the fins are particularly open so that the hydraulic diameter of the passages enclosed thereby may be sufficiently high as not to constitute an obstacle to convective motion thus allowing a free circulation of the viscous liquid surrounding the heating elements.

It is further to be observed that in the manner described a useful increase in heating surface is achieved, at the same time maintaining the greater portion of the extended surfaces on almost vertical planes, like those of the fins. The possibility of deposits on the tubes is thus reduced to a minimum, being limited at most to the very small percentage-area lying on a horizontal plane.

The second great advantage achieved by the arrangement described, is to be able to utilize, for heat transfer purposes, the movements communicated to the viscous liquid contained in the tanks or double bottoms by the rolling of the vessel. Such movements, which actually help the uniform distribution of heat in the viscous liquid, are in no wise impeded by the fins as herein described.

Apart from the phenomenon of rolling, which may not exist if one considers the heating of the viscous liquid in the tanks in port, the convective motion of said viscous liquid will never be impeded in the slightest by the vertical surfaces of the fins of the tubes arranged horizontally or by the vertical surfaces of the fins on the tubes arranged vertically, as would be the case, for example, of surfaces extending longitudinally on tubes arranged in an horizontal plane or of surfaces extending radially on tubes arranged in vertical planes.

The series of finned elements are hot-forced onto the steel pipes and the connection between the respective sleeves is ensured by a special spigot and socket joint. This joint, however, may be achieved in various ways without departing from the scope of the present invention. The finned pipes can be constructed in straight lengths up to 5 metres and more, thus making it possible to reduce to a minimum the number of joints, giving increased safety in service. The pipes are inserted within the transverse floor of the vessel, or fixed to these according to the particular structure, so as to be able to be laid between the longitudinals and parallel to the same (Figs. 1, 2 and 3). The pipes are supported by means of strip iron anchor collars or other extremely simple devices, allowing said pipes freedom to expand. The straight lengths of finned elements are jointed together by flanges ensuring leakproof connections.

Similar joints are employed to ensure perfect junction between the various rows of heating elements, said joints consisting of steel bends, flanged e.g. pipes E, either bare or clad with cast iron, without fins. The steam inlet pipes and the condensate outlet pipes, can be partly protected by the cast-iron sleeves already described. In this case, however, said cast-iron sleeves bear longitudinal fins and the pipes are generally arranged in vertical position on the end bulkheads of the tanks or double bottoms and are generally suspended on said bulkheads without supporting brackets, so as to allow free expansion of the coils.

One of these vertical pipes may be profitably situated near the inlet end of the suction pipe of the pump for the viscous liquid, so as to intensify the heating of said liquid in that neighbourhood. The shape of the fins as projected and the various heat transfer coefficients between steel and cast iron are such as to maintain the highest performance of the heating surface in practice. In this way, with the present invention the following advantages can be achieved:

1) A very long life for the coils (very many years), mainly due to the resistance to corrosion of cast-iron of an acceptable quality.

2) Reliability in service due to the high mechanical strength of the internal parts made entirely of steel.

3) Greatly reduced running costs as compared with other steel or cast-iron systems at present employed.

4) A reduction of the heavy expenditure attendant upon laying up of a ship to replace worn out pipes as a result of the increased period of time before replacement becomes necessary.

5) Substantial increase in the ratio between the heating surface and the weight; in other words, a reduction of the inverse ratio between weight and heating surface, which gives a system weighing very much less than any other conventional system having equal heat yield.

For example it is to possible to design a heating system built according to the invention which has a weight to heating surface ratio of only 21 Kg/square metre approximately.

6) Possibility of dividing the heating circuit into a plurality of circuits independent of each other and connected in parallel, thanks to the reduced weight per unit length of the pipe used. This arrangement, in practice, ensures the ready location of a section of the heating system which is out of operation for any reason and to cut it off from the pipeline without precluding the operation of the remaining part of the plant.

WHAT I CLAIM IS:—

1) A heat exchanger for heating fuel or other viscous liquids carried in tanks or double bottoms of a ship, comprising a container constituted by the inner surfaces of the tanks or double bottoms in which the viscous liquid to be heated is stored, and a plurality of conduits or pipes disposed in said container for transmitting heating fluid internally therethrough, each of said conduits or pipes including an inner tubular steel conduit and an outer externally finned cast iron jacket mounted on the tubular conduit in such manner as to prevent the fuel oil or other viscous liquid from coming into contact with the steel conduit, means being provided for introducing heating fluid into each conduit or pipe and for discharging said heating fluid after it has passed through said conduits or pipes.

2) A heat exchanger according to Claim 1 wherein a first plurality of conduits or pipes are arranged in a substantially horizontal plane near the bottom of the container and a second plurality of conduits or pipes connected to the first plurality are disposed in a substantially vertical plane.

3) A heat exchanger according to Claim 2 wherein an inlet valve and manifold are mounted near the top of the container for introducing the heating fluid into the pipes or conduits for transmission therethrough and an outlet valve and manifold are mounted near the top of the container for discharging the heating fluid after it has passed through the pipes or conduits.

4) A heat exchanger according to Claim 2 wherein the fins on said first plurality of conduits or pipes extend radially from and transversely to the axes of these said conduits or pipes and wherein the fins on the second plurality of conduits or pipes extend radially from and longitudinally to the axes of the latter pipes or conduits.

5). A heat exchanger according to any of the preceding Claims wherein the co-operating surfaces of the outer cast iron jacket and the inner tubular steel pipe or conduit respectively are machined and the jacket is applied to the pipe or conduit under heat and pressure.

6). A heat exchanger for heating fuel oil carried in the hold of a ship substantially as described and illustrated in the accompanying drawings.

Dated this 24th day of July, 1953.

HASELTINE, LAKE & CO.,
28, Southampton Buildings,
London, England,
Agents for the Applicant.

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742,683 AMENDED SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

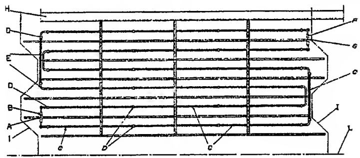

Fig. 1

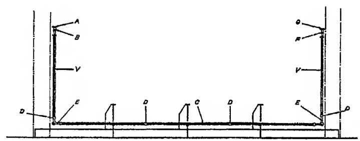

Fig. 2

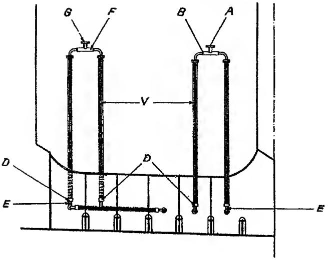

Fig. 3

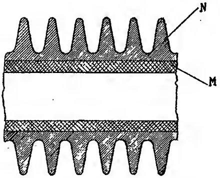

Fig. 4